NEW TOPIC: CLOUDS

Air contains moisture. The moisture comes from lakes, oceans, land surface and vegetation. The amount of water vapour present in the air is called **humidity**. Water vapour is the most important atmospheric gas which influences weather changes on Earth

Studying the hydrological cycle

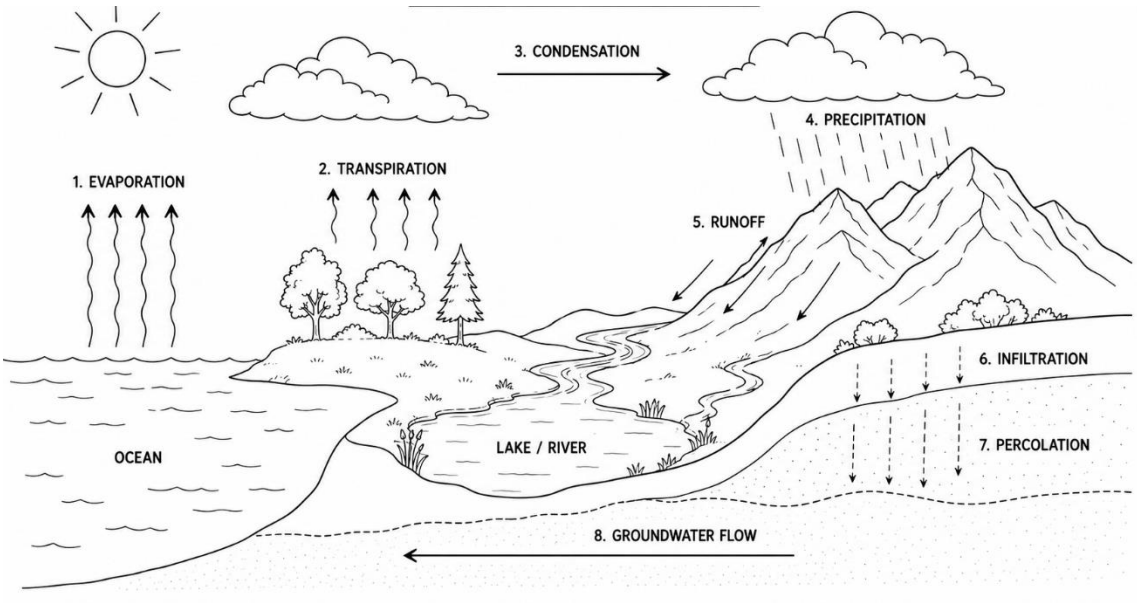

Figure 1 *The hydrological cycle*

Features of the hydrological cycle and their importance

- Sun
- Clouds
- Water bodies
- Groundwater
- Land
- Vegetation

Processes of the hydrological cycle

- Evaporation (water from land and water bodies)
- Transpiration (trees lose water due to Sun's heat)
- Condensation (water vapour changing into droplets of water called **clouds**)
- Precipitation (rain, hail, sleet, snow)
- Infiltration (rainwater soaks into the soil)
- Percolation (**horizontal flow** of underground water)
- Surface run-off (water flowing on the surface when it is raining)

FACTORS THAT ENCOURAGE INFILTRATION

- **Flat land or Gentle slopes** – Water moves slowly over flat land, giving it more time to soak into the ground.
- **Permeable soils and rocks** –Sandy soils and porous rocks allow water to infiltrate easily.
- **Dry soil conditions** – Dry soils have more available pore spaces to absorb water.
- **Light or moderate rainfall** – Water falls slowly enough for the soil to absorb it**.**
- **Dense vegetation cover** – Vegetation slows surface flow and increasing infiltration.
- **Absence of impermeable surfaces** – Concrete and asphalt reduce infiltration.

FACTORS WHICH ENCOURAGE SURFACE RUN-OFF

- **Heavy rainfall** – When rain falls faster than the ground can absorb it, excess water flows over the surface.
- **Steep slopes** – Water moves downhill quickly, reducing the time available for infiltration.
- **Impermeable rocks or soils** – Compacted soils and rocks prevent water from soaking into the ground.
- **Saturated ground** – When the soil is already full of water, additional rainfall cannot infiltrate and becomes run-off.
- **Absence of vegetation** – Lack of plants reduces absorption, allowing more water to flow over the surface.
- **Urbanization** – Roads, pavements, and buildings create impermeable (hard) surfaces that increase run-off.

FACTORS THAT DISTURB THE HYDROLOGICAL CYCLE

- Cutting down trees carelessly reduces transpiration will be reduced
- Setting of harmful bushfires clearing all grass hence reducing transpiration
- Dumping of industrial wastes in oceans, rivers and lakes result into water pollution
- Air pollution through factory fumes, smoke from cars will lead to ozone destruction.
- Overstocking, this is keeping of a greater number of animals than the area can accommodate.
- Acid rain makes the soil acidic and some trees die because of acidic conditions.

- Global warming causes droughts which reduce rainfall. Global warming may also lead to too much rainfall.

HOW CLOUDS ARE FORMED

Insolation (Sun's heat) causes water in lakes, vegetation and land to evaporate and rise into the atmosphere. When the rising moisture reaches the **condensation level** it cools and condenses around dust particles, salt particles and smoke which act as **condensation nuclei**. When billions of these droplets come together, they become a visible **cloud.** With time, droplets become bigger and heavy. They start to fall down in form of **precipitation**.

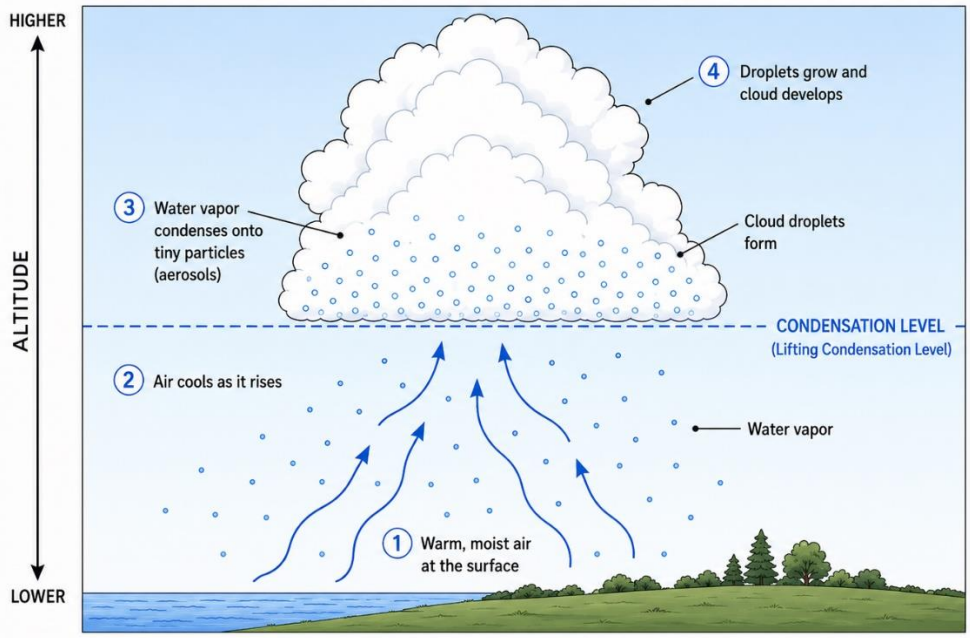

***Figure 2**: How clouds are formed*

What is dew point temperature?

Is the temperature at which water vapour in the atmosphere condenses to form tiny droplets of water. Is the temperature at which air cannot hold more water.

What are condensation nuclei?

These are dust particles, aerosols, salt crystals and smoke around which water vapour collects during condensation in the air.

What is condensation level?

It is the height in the atmosphere at which rising air becomes cool enough to cause water vapour to turn into tiny water droplets, forming clouds. In weather diagrams, it is usually shown as a **horizontal line** marking the bottom of a cloud. Look at the diagram above.

CONDITIONS FOR THE FORMATION OF CLOUDS

1. **Air must be saturated (full of water vapour):** There must enough water vapour in the air to form tiny droplets of water.
2. **Low temperature:** The air should be cooled to its dew point so that it turns the water vapour into liquid.
3. **Enough dust particles, aerosols and smoke:** These provide a surface on which water molecules should collect. This dust comes from the earth's surface.

IDENTIFYING TYPES OF CLOUDS FROM PHOTOGRAPHS OR DIAGRAMS

Clouds are classified according to appearance and height (whether they form near the surface or higher up in the atmosphere)

a. TYPES OF CLOUDS ACCORDING TO APPEARANCE

Name of cloud	Appearance	Associated weather conditions
Cumulus (heap)	Like a heap or pile, rounded top, flat base, like balls of cotton	thunder
Stratus (layer)	Like layers, do not appear as individual cloud units (fog)	Foggy conditions,
Cirrus (hair-like)	Like feathers, spirals of hair	Fair weather
Nimbus (rain)	Anvil shaped, white-black,	Rains

Table 1 *Types of clouds based on appearance*

b. TYPES OF CLOUDS ACCORDING TO HEIGHT or ALTITUDE

Clouds form at different heights in the atmosphere. Others like fog appear very close to the earth surface while Cirrus forms higher up in the atmosphere.

1. LOW CLOUDS: Below 2000 metres.

They form nearer to the surface and they look like they move faster than high clouds when observed from the ground. Most of them are **strato** clouds and are associated with **drizzles**.

Examples include:

- Stratocumulus
- Nimbostratus (bring continuous rains, snow, sleet)
- Stratus (looks like fog, brings **cloudy** weather and drizzle, reduces visibility making air travel dangerous)
- Fog

2. **MIDDLE CLOUDS**

They form at temperatures below freezing point **0^0C**.

- **Altostratus**: covers entire sky. Sun looks **hazy (blurred or not clear)** with a bright spot sky in the cloud. Indicates that **bad weather** is coming.
- **Altocumulus**: Looks like balls of cotton. Usually a sign of fair weather.

3. **HIGH CLOUDS**

Composed of ice crystals. Do **not** bring rains but may indicate that storms are coming. Such clouds form a **halo** which is a **ring of light that encircles** the sun or moon.

- **Cirrus cloud**: Looks like feathers. Show fair weather. Gives a brilliant sunset.
- **Cirrostratus**: Have a hazy appearance. Produces a **halo** (circle of light) around the sun and moon since sunlight is refracted through ice crystals. Haloes are a sign that storms or showers are coming.
- **Cirrocumulus**: Looks like ripples in the sand. Storms and bad weather approaching.

4. **CLOUDS OF GREAT VERTICAL EXTENT**

They stretch from lower atmosphere upwards to the highest levels of the troposphere. Formed because of intense heating of the surface which causes vertical or upward movement of air.

- **Cumulonimbus**: Brings hailstorms and torrential rains accompanied by thunder and lightning. Looks like a mushroom or an anvil. Also called "**thundercloud**"
- **Cumulus**: round topped, flat base.

New Topic: PRECIPITATION

Precipitation is any form of water (liquid or solid) falling from the atmosphere on to the surface of the earth.

MAJOR FORMS OF PRECIPITATION

1. **Rain**

Is the falling of water in liquid form from the atmosphere. Rain is formed when water vapour cools and forms tiny water droplets. Water droplets join together and grow bigger. Eventually, they become heavy and fall to the ground as drops of rain.

2. **Hail**

Is the falling of lumps of frozen rain from the atmosphere to the surface. Hail forms at the top of the towering Cumulonimbus clouds which reach way high up in the atmosphere. Ice crystals form and get bigger as they fall. Hail is associated with thunderstorms.

3. **Snow**

Snow is form in the same way as hail but looks different. With snow, ice crystals join together to form ***snowflakes***.

4. **Sleet**

Is frozen raindrops that form due to freezing of drops as the fall to the surface.

5. **Drizzle**

Is very fine rain with very tiny raindrops. Drizzles fall from low level Stratus clouds. Associated with poor visibility and fog.

6. **Fog**

Fogs form when a warm moist wind blows over a cool mountain top, it is cooled, and its vapour becomes visible in the form of a fog. At night, when the sky is clear, the earth rapidly loses heat which it has received from the sun during the day. Its surface quickly becomes cold. The air near the cool ground is also cooled until it condenses to form clouds near the surface. A fog is seen in the morning but disappears as the sun warms the surface.

7. **Mist**

Mist is formed in the same way as fog. The difference is that visibility is better in a mist than a fog.

8. **Dew**

This name is given to the moisture which appears in the evening or at night upon grass, leaves, stones, or other surfaces. At night, when the sky is clear, the earth rapidly loses heat which it has received from the sun during the day. Its surface quickly becomes cold. The air near the cooled ground is also cooled until it condenses to form water droplets on surfaces like grass, stones and trees. Dew evaporates after the Sun rises and it becomes warmer.

9. **Frost**

When temperatures quickly decrease to below **0^0C**, water vapour turns directly into ice crystals called **frost**. Frost forms on surfaces of trees and other objects.

CONDITIONS NECESSARY FOR PRECIPITATION

1. The air must rise to a high altitude.
2. The air must be cooled below its dew point. **DEW POINT**: The point at which vapour condenses and turns into droplets of water called clouds. This is below **0^0C**.This is also called condensation level.
3. Humidity should be high.
4. The air must contain small particles of matter such as dust, salt, ice, pollen grains and soot. These small particles of matter form the **condensation nuclei** around which droplets form.

EXPLAIN HOW PRECIPITATION IS FORMED

Several processes are involved for precipitation to occur.

1. When the **air is heated**, it absorbs moisture from the land, sea and plants.
2. The warm moist air rises and then it is cooled before **dew point.**
3. The water vapour changes into water droplets through **condensation** and suspended in the atmosphere in form of clouds.
4. When **droplets** become very heavy that they cannot be suspended in the air, they fall down in form of precipitation.

NEW TOPIC: RAINFALL

This refers to the falling of water droplets from the atmosphere to the ground.

TYPES OF RAINFALL

There are **three** types of rainfall.

1. Convectional rainfall
2. Relief rainfall
3. Frontal rainfall

A. CONVECTIONAL RAINFALL

This is formed when heated warm air is forced to rise in form of **convection currents**. The rising air carries moisture which then cools as it goes up until at last the vapour condenses to form cumulonimbus clouds and rain falls heavily in the afternoon. The rains are accompanied by lightning, thunderstorms and hail.

DIAGRAM OF CONVECTIONAL RAINFALL

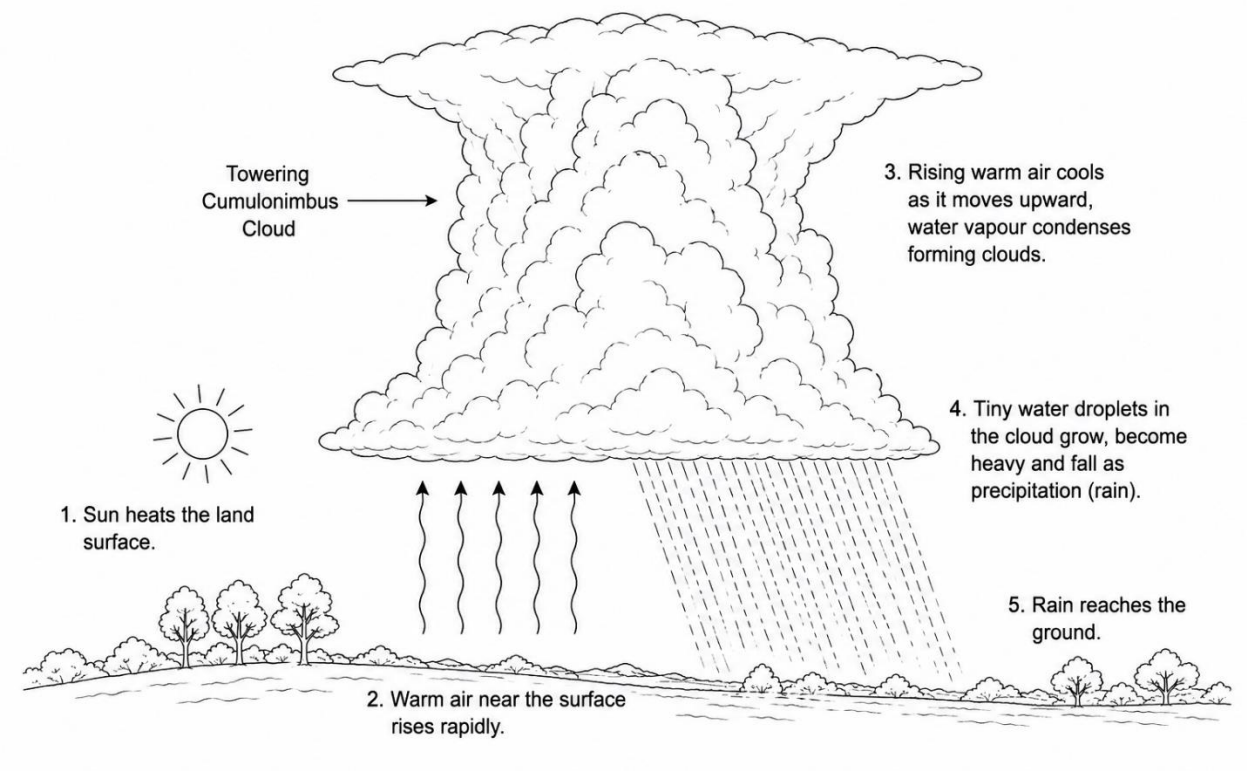
Towering Cumulonimbus Cloud
3. Rising warm air cools as it moves upward, water vapour condenses forming clouds.
4. Tiny water droplets in the cloud grow, become heavy and fall as precipitation (rain).
1. Sun heats the land surface.
5. Rain reaches the ground.
2. Warm air near the surface rises rapidly.

Figure 3 *Convection rainfall. Notice the anvil-shaped Cumulonimbus cloud*

CHARACTERISTICS OF CONVECTIONAL RAINFALL

- It is associated with anvil-shaped clouds called **cumulonimbus.**
- It is associated with **lightning** and thunderstorms.
- It falls heavily, but it is short-lived (it lasts for a short time).
- It covers a small area.
- It usually falls in the **afternoon** after air has been extremely heated.

AREAS WHERE CONVECTIONAL RAINFALL USUALLY OCCURS

It occurs in the **equatorial or tropical regions** such as **Democratic Republic of Congo**, **Amazon Basin, Ghana** and **Malawi**. **High temperatures heat the** earth his makes heated air to rise in form of convection currents with moisture.

B. RELIEF OR OROGRAPHIC RAINFALL

Relief rain occurs due to the presence of physical features such as mountains or hills. Moist air is forced to rise over a mountain. Rising of air leads to condensation which forms and rain falls. Rain falls on the **windward side**. The winds descend on the **leeward side** as warm and dry wind. Therefore, the leeward side receives little or no rainfall. It is called **relief rainfall** because it is influenced by physical features such as hill, mountains.

DIAGRAM OF RELIEF OR OROGRAPHIC RAINFALL

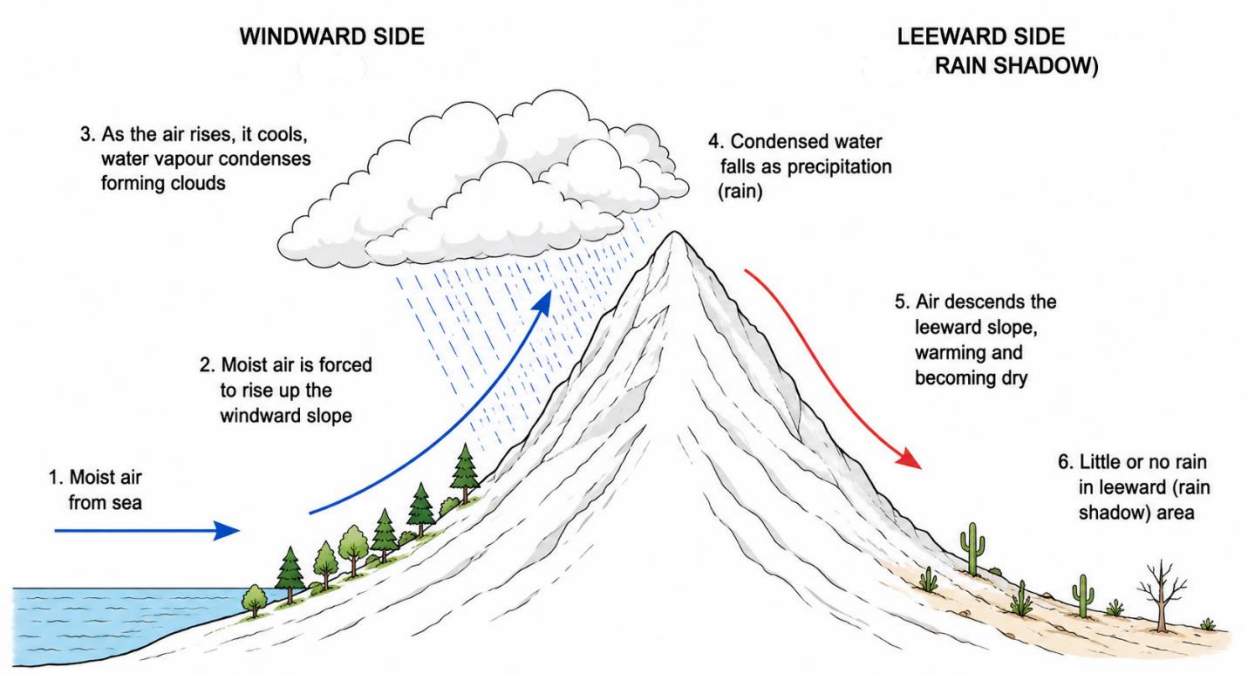
WINDWARD SIDE
LEEWARD SIDE
RAIN SHADOW)
3. As the air rises, it cools, water vapour condenses forming clouds
4. Condensed water falls as precipitation (rain)
5. Air descends the leeward slope, warming and becoming dry
2. Moist air is forced to rise up the windward slope
1. Moist air from sea
6. Little or no rain in leeward (rain shadow) area

Figure 4 *Relief rainfall*

CHARACTERISTICS OF RELIEF OR OROGRAPHIC RAINFALL

- It falls where mountains cause warm moist to rise.
- It falls on the **windward side** only. Windward side of the mountain faces the source of the moist air or rain bearing winds.
- The leeward side receives little or no rainfall at all **because the descending winds are without moisture after losing it on the windward side.**

  Another name for the windward side is **rain shadow area**.

AREAS WHERE RELIEF RAINFALL USUALLY OCCURS

It falls all over the world provided there are mountains, lakes and winds. For example, the windward side of the Rockies in North America, Himalayas in India and Mulanje mountain in Malawi.

C. FRONTAL/DEPRESSION OR CYCLONIC RAINFALL

This type of rainfall occurs when air masses of different temperatures meet. When this happens, the warm air which is less dense rises over the cooler air. The rising of this warm air causes moisture to cool after reaching the dew point, forming clouds. These clouds bring

rainfall. Between the warm air and cold air, a boundary called **FRONT** is formed hence **frontal rainfall**.

DIAGRAM OF FRONTAL RAINFALL

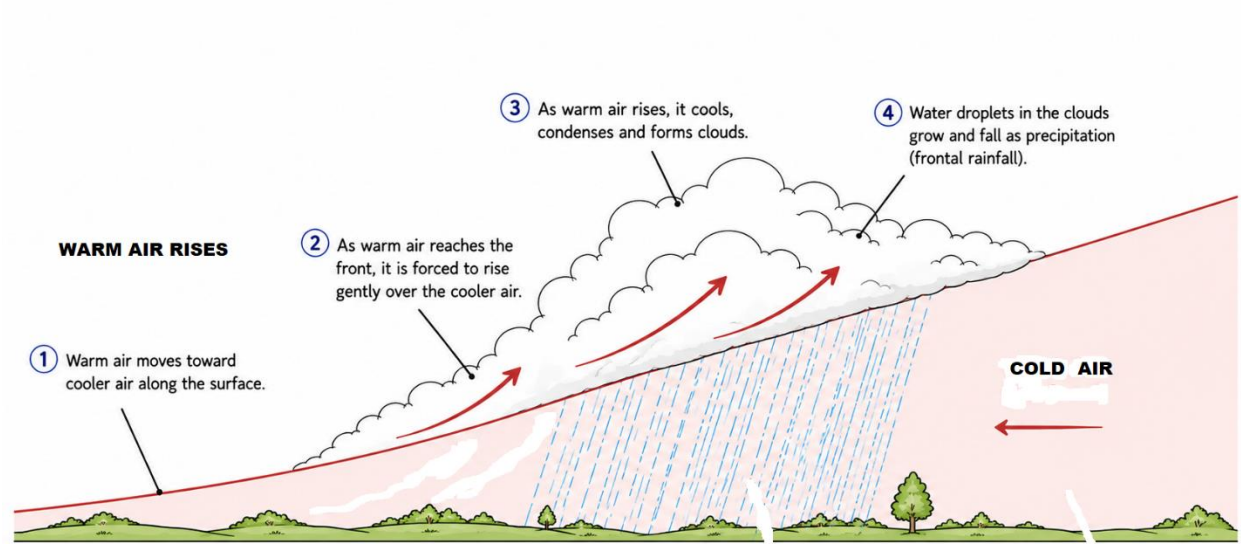
3 As warm air rises, it cools, condenses and forms clouds.
4 Water droplets in the clouds grow and fall as precipitation (frontal rainfall).
WARM AIR RISES
2 As warm air reaches the front, it is forced to rise gently over the cooler air.
1 Warm air moves toward cooler air along the surface.
COLD AIR

Figure 5 *Frontal rainfall*

CHARACTERISTICS OF FRONTAL RAINFALL

- Associated with **dark stratus** or **nimbostratus** clouds
- Associated with storms or cyclones
- In tropical regions, it usually lasts for few hours but **heavy** followed by clear skies.
- In temperate areas, the rain may persist for several hours or days.
- Formed due to meeting of air masses of different temperatures.

AREAS WHERE THIS TYPE OF RAINFALL OCCURS

Such type of rainfall occurs in the areas **where warm tropical air masses meet with the cold air masses** of temperate areas e.g. Britain, Canada and South Africa.

SIMILARITIES IN ALL TYPES OF RAINFALL

- In all the three types, **warm moist** air rises.
- In all the three types the rising air **must get cooled**.
- In all the three types **clouds** must be formed for precipitation to take place.

HOW TO INTERPRET RAINFALL DATA FROM GRAPHS AND MAPS

Rainfall and temperature data is shown on tables or plotted on graphs or maps.

Understanding rainfall and temperature data on a table.

Study the climatic table and answer the questions that follow.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp (°C)	7	8	11	18	22	22	24	24	21	17	12	18
Rain (mm)	81	69	74	66	56	41	18	25	64	127	112	99

Table 2 *Rainfall and temperature data*

1. In which month did the area receive least amount of rainfall? **(1 mark)**
2. Which month was the coldest? **(1 mark)**
3. Describe the pattern of the rainfall from January to December. **(4 marks)**
4. What is the mean annual temperature for the area? **(3 marks)**
5. Describe the patterns in temperature and rainfall, including how they relate to each other. **(2 marks)**

Understanding rainfall and temperature data on a graph.

Study the climatic graph and answer the questions that follow.

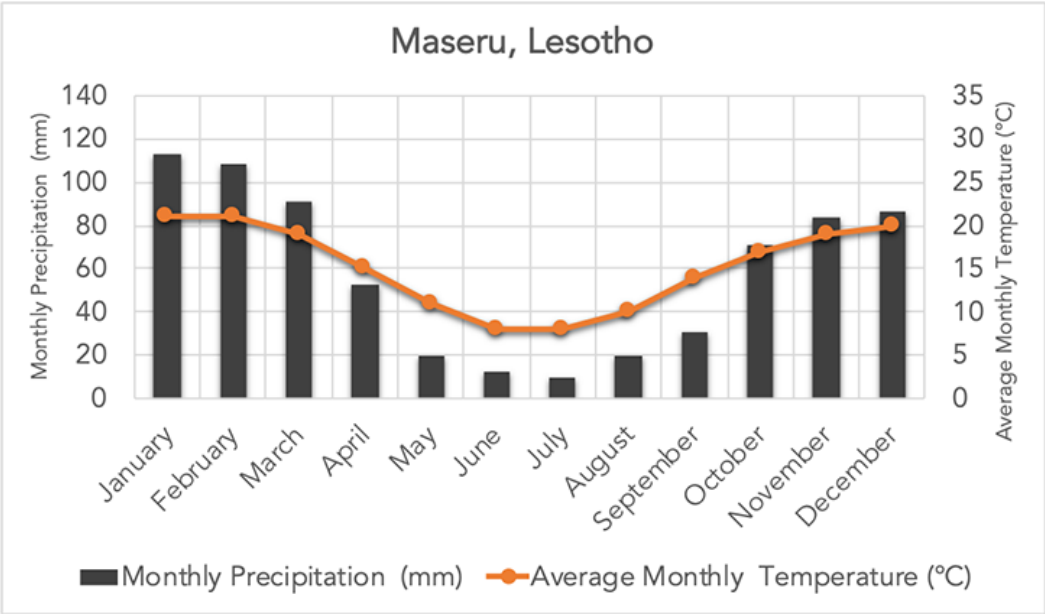

Figure 6 *Climatic graph for Lesotho*

Note: We have a bar graph for rainfall and line graph for temperature.

Parts of a Climatic Graph

a. **Months (X-axis)** – January to December.
b. **Rainfall (left)** – shown by bars, measured in millimetres (mm).
c. **Temperature (right Y-axis)** – shown by a line graph, in degrees Celsius (°C).

When interpreting climatic graphs:

1. Look at the overall **shape** of the graph. Is the temperature line **steep** or **gentle**? Does it change throughout the year or look almost flat?
2. Look for **extremes.** Find the highest and lowest temperature and rainfall and the month in which it occurs.
3. Identify the seasons when most rain or least rain falls? Or when the highest and lowest temperatures are experienced?
4. Find the temperature range by subtracting the lowest figure from the highest figure.
5. Add the rainfall totals for each month together to find the total annual rainfall.

Determine the hemisphere from which the data was recorded

- If temperatures rise around **June–August**, the station is likely in the **Northern Hemisphere**.
- If temperatures rise around **December–February**, the station is likely in the **Southern Hemisphere** (e.g., Malawi).